REMARKS

This paper is in response to the final Office Action mailed October 12, 2005. Claims 1-16 are pending upon entry of this paper.

Response to 35 U.S.C. § 112 Rejection

Claims 10-16 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. The Examiner indicates that the limitations of "converting said ion beam into an energized monochromatic beam of neutrals by directing said ion beam through a charge transfer chamber containing a volume of relatively slower moving neutrally charged gas atoms or molecules" and "forming a cloud of thermalized sputtered particles proximate to a substrate, wherein the cloud is formed by increasing the number of collisions between gas molecules and sputtered particles to decrease the directional momentum of said sputtered particles as they propagate toward the substrate" could not be located in the specification, and thus the subject matter is considered to be new. Applicant respectfully traverses this rejection.

With respect to the limitation of "converting . . .", beginning at line 10 of paragraph [0017], the specification recites:

> Said extracting system 2 provides optics means, preferably by way of an applied electric field, to equalize, shape, focus, and direct individual positively charged ions of said fast moving positively charged ion beam into a charge transfer chamber 3 containing a volume of relatively slow moving neutrally charged gas atoms or molecules. Said volume of relatively slow moving neutrally charged gas atoms or molecules contained inside charge transfer chamber 3 provide charge transfer means for converting said positively charged ion beam into an energy-monochromatic beam of neutrals 28 by way of an ion neutralization process founded on the principle of charge transfer phenomenon. Such charge transfer phenomenon is shown to occur when said relatively fast moving positively charged ions, having been directed into said charge transfer chamber 3, collide with said volume of relatively slow moving neutral gas atoms or molecules contained inside said charge transfer chamber 3.

Therefore, the limitation of "converting . . ." is supported by the specification as originally filed. Applicant further points out that claim 1 as originally filed contains the element of "converting said ion beam into an energized monochromatic beam of neutrals". Accordingly, Applicant respectfully requests that the Examiner reconsider this rejection.

With respect to the limitation of "forming a cloud . . .", beginning on line 1 of paragraph [0018], the specification recites:

> Referring again to Fig. 1, the method of the present invention also includes the step of formation of a cloud 6 of sputtered material directed toward a substrate 7 for deposition. A gradual increase in the density of cloud 6 as best shown in Fig. 1 is achieved by a thermalization process whereby gas pressure in the sputtering chamber transport region is maintained at a higher level compared to conventional PVD. Such higher gas pressure increases the number of collisions between gas molecules and said sputtered particles 30 which in turn decreases the directional momentum of said sputtered particles 30 as they propagate along the transport region toward said substrate 7.

Therefore, the limitation of "forming a cloud . . ." is supported by the specification as originally filed. Applicant further points out that claim 1 as originally filed contains the element of "forming a cloud of said sputtered particles proximate to a substrate". Accordingly, Applicant respectfully requests that the Examiner reconsider this rejection.

Response to Rejection of Claim 1

Claim 1 is directed to a physical vapor deposition (PVD) method for deposition of dielectric materials, including low dielectric constant (low-k) materials, onto substrates during the fabrication of integrated circuits and other electronic, opto-electronic, microwave, and micro electro-mechanical (MEM) devices. More particularly, claim 1, is directed to a method for the physical vapor deposition of dielectric material onto a substrate comprising, *inter alia*:

> forming an energized monochromatic ion beam;
>
> converting said ion beam into an energized monochromatic beam of neutrals;

directing said beam of neutrals toward a sputtering target;
exposing said target to bombardment by said beam of neutrals;
sputtering particles from said target;
forming a cloud of said sputtered particles proximate to a substrate; and
depositing said sputtered particles onto said substrate

Claim 1 in the application stands rejected as being anticipated by Katsube et al. (U.S. Patent No. 5,292,122). Applicant respectfully traverses this rejection. Claim 1 is novel and patentable over the references of record, and particularly over Katsube et al., because the cited art does not show or suggest a method for the physical vapor deposition of dielectric material onto a substrate comprising forming a cloud of sputtered particles proximate to a substrate as required by claim 1.

Katsube et al. discloses a method of forming a hydrophobic film on a substrate by irradiating a target consisting of a hydrophobic compound with a neutral atom beam and thereby effecting sputtering. As can be seen in the Figures of the Katsube et al. reference, the apparatus for effecting the sputtering comprises a target base disposed in a vacuum chamber, an atom beam gun for irradiating a target on the target base with a neutral beam, a substrate base and a shutter for controlling the passage of sputtered particles. According to Katsube et al., argon atoms are directed into the gun 11 where they are ionized by high voltage, and the ions thus generated are accelerated in an electric field. Ion charges are then neutralized by the electronic atmosphere in the neighborhood of gun 11, thus generating a high-speed neutral ion beam. (Katsube et al., Summary of Invention, Embodiment 4, Fig. 6).

Katsube et al. do not teach or suggest forming a cloud of sputtered particles proximate to the substrate as required by claim 1. The Examiner admits that the Katsube et al. reference does not specifically teach or suggest this limitation. Instead the Examiner contends that the cloud is inherently formed by the Katsube apparatus by increasing the collisions because the collisions would increase with an increased voltage. In response to the first Office Action, Applicant provided arguments why the apparatus disclosed in the Katsube et al. reference would not form a cloud of sputtered particles. A declaration under 37 C.F.R. § 1.132 is submitted with this amendment reiterating Applicant's belief that no such cloud would be formed by the Katsube apparatus. Despite

the arguments in Applicant's prior response, the Examiner still has not provided evidence tending to support inherency of this feature. The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *See In re Rijckaert*, 9 F.3d 1531, 1534, 28 U.S.P.Q.2d 1955, 1957 (Fed Cir. 1993). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may resut from a given set of circumstances is not sufficient.'" *In re Robertson*, 169 F.3d 743, 745, 49 U.S.P.Q. 2d 1949, 1950-51 (Fed. Cir. 1999). *See also*, MPEP § 2112(IV). The Examiner has yet to show where the missing descriptive matter is necessarily present in the Katsube et al. reference.

Paragraph [0018] of Applicant's specification defines the cloud of sputtered particles as an increased density of thermalized sputtered particles. The thermalization occurs when the gas density in the transport region is high enough to provide intense elastic collisions between sputtered particles and atoms of residual gas. This can be achieved by increasing the gas pressure so that the mean free path of elastic collisions becomes small relative to length of transport region, providing intensive kinetic energy and momentum exchange between sputtered particles and atoms of the residual gas. These collisions create the isotropy in sputtered particle momentum and reduce its kinetic energy to a "cold" level. The thermalization reduces the energy brought by depositing particles to the film.

The Leybovich Declaration points out that it is believed that the method taught by Katsube et al. would not form a cloud of sputtered particles. In fact, Katsube et al. teach away from the establishing the conditions that cause the formation of a cloud. A relatively low residual gas pressure (density) of $3x10^{-5}$ Torr (Katsube et al., Embodiment 1) to $2x10^{-4}$ Torr (Katsube et al., Experiment 4) with mean free path of elastic collisions in the range of tens of centimeters and extremely low sputter/deposition rate do not provide conditions for formation of a sputter particle cloud. At this gas pressure, it is believed that every particle emitted by the target would reach the substrate practically without collision. For this reason, these sputtered particles bring their original kinetic energy of several eV to the film. This energy is much higher than the energy of thermalized sputter particles. This seems to be a possible reason why the growing films in the apparatus depicted

in the Katsube et al. reference require cooling in spite of an almost negligible deposition rate (Fig. 8). Thus, the formation of a cloud as required by claim 1 is not inherent in the operation of the Katsube et al apparatus.

Accordingly, claim 1 is not anticipated by or made obvious by the cited reference and favorable consideration of claim 1 is respectfully requested. Claim 15 contains limitations similar to the one described above. Therefore, these claims are patentable for at least the same reasons. Claims 2-5, 10-14 and 16, depending directly or indirectly from one of claim 1 or 15 are submitted as patentable over the cited references for at least the same reasons.

With reference to claims 10 and 11, the present invention uses a very different approach of converting the ion beam into an energized monochromatic beam of neutrals. The principal difference is in utilization of a charge-transfer chamber to convert gradually fast ions into atoms along the path of beam propagation. As shown in Fig.1, the monochromatic ion beam, which has a nearly zero fast atom component in the vicinity of the either side of ion optics aperture 2, propagates along charge-transfer chamber 3, which is filled with a gas, such as rarified Ar gas. The pressure of rarified gas inside chamber 3 may not be equal to the open vacuum of the Katsube apparatus. (Katsube, Fig.1, 6). Instead, the pressure inside of chamber provide a charge-transfer collision process between fast Ar^+ and low energy Ar^0 atoms. An ion energy in the range of 100-400 eV provides a preferable cross-section for charge transfer collision process between Ar^+ and Ar^0. For this additional reason, claims 10 and 11 are patentable over the cited art.

Response to Rejection of Claim 6

Claim 6 is directed to a physical vapor deposition (PVD) system for deposition of dielectric materials, including low dielectric constant (low-k) materials, onto substrates during the fabrication of integrated circuits and other electronic, opto-electronic, microwave, and micro electro-mechanical (MEM) devices. More particularly, claim 6, is directed to a system for the physical vapor deposition (PVD) of dielectric material onto a substrate comprising, *inter alia*:

a sputtering target;

a low energy, large aperture ion source of energized monochromatic ions;

an ion optics system for equalizing, shaping, and directing said ions into an

ion beam;

a charge transfer system for neutralization of said ion beam into a beam of neutrals;

means for directing said beam of neutrals toward the target, said beam of neutrals bombarding said target and causing said target to emit sputtered particles;

means for forming a cloud of said sputtered particles proximate said substrate; and

means for depositing said cloud of said sputtered particles onto said substrate.

Claim 6 in the application stands rejected as being obvious in view of Katsube et al. in view of the non-patented art of Shimokawa (hereinafter "Shimokawa"). Applicant respectfully traverses this rejection. Claim 6 is novel and patentable over the references of record, and particularly over Katsube et al. and Shimokawa, because the cited art does not show or suggest a system for the physical vapor deposition (PVD) of dielectric material onto a substrate comprising a charge transfer system for neutralization of said ion beam into a beam of neutrals and means for forming a cloud of said sputtered particles proximate said substrate as required by claim 6.

In paragraph 15, the Examiner states that Katsube et al. teach the limitations of claim 6 with the exception of the specifics of the ion/neutral beam source. However, as set forth above, Katsube et al. do not teach or suggest forming a cloud of sputtered particles. Shimokawa discloses a new high-power fast atom beam source. Shimokawa also does not teach or suggest the formation of a cloud of sputtered particles. Therefore, Shimokawa cannot cure the deficiencies of Katsube et al.

Accordingly, claim 6 is not anticipated by or made obvious by the cited reference and favorable consideration of claim 6 is respectfully requested. Claims 7-9, depending directly or indirectly from claim 6, are submitted as patentable over the cited references for at least the same reasons.

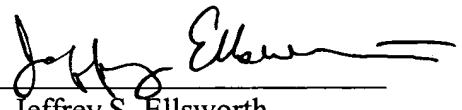
Conclusion

In view of the remarks made herein, Applicant submits that the claims presented herein are patentably distinguishable from the art applied and prompt allowance of the application is respectfully requested.

Should the Examiner determine that anything else is desirable to place this application in even better form for allowance, the Examiner is respectfully requested to contact the undersigned by telephone.

Respectfully submitted,

WEGMAN, HESSLER & VANDERBURG

By 

Jeffrey S. Ellsworth
Reg. No. 51,450

Suite 200
6055 Rockside Woods Boulevard
Cleveland, Ohio 44131
216/642-3342

November 3, 2005